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(54) **Image transfer process and carrier material therefor.**

(57) A flexible sheet image carrier for use in transferring images to target textile substrates comprises a base material, for example limp latex-impregnated paper, with an extruded polymeric surface layer, and a thermoplastic transfer coating thereon that is separable from the polymeric surface under heat and pressure when in face to face contact with the target substrate. The transfer coating, which may be arc treated to enhance its receptivity, receives the image by a xerographic method, and the image carrier meets photocopier industry standards for copy papers. Transfer coating materials include ionomer resins, ethylene-butyl acrylate copolymers and ethylene-vinyl acetate copolymers, which together with low density polyethylene are also suitable for the polymeric surface to the paper base carrier web.

This invention relates to an image transfer process and to an image carrier material for use in such a process.

The invention has been devised for use in printing textile materials in conjunction with photocopying technology. Firstly, an image is formed on an intermediate carrier material by xerographic means, and secondly, the image is physically transferred from the carrier to a target substrate. The carrier may simply replace the conventional photocopy paper in a commercially available photocopier, which may then form a black or coloured image on the carrier. The image may be semi-permanent on the carrier, enabling the carrier to be handled without risk to the integrity of the image, but permitting transfer to the target substrate under particular conditions. The image is desirably substantially permanent once it has been transferred to the target.

One of the objects of the invention is to provide economical and versatile means for transferring single images to textile fabrics in a bespoke manner. A particular application is in printing images on to tee-shirts.

Image transfer processes are known in which an image is formed in xerographic toner by a xerographic process on a carrier sheet, and then fixed to the sheet, after which the image-bearing carrier sheet is placed in face to face contact with a target substrate of textile material, and by the application of heat and pressure the toner image is transferred to the textile substrate. However, the quality of the image transfer step, and the durability of the image on the target material after it has been transferred, are often poor.

According to the invention the image transfer process comprises providing an image carrier sheet comprising a flexible web base having a surface layer of polymeric material, and on the said surface layer of the base a thermoplastic coating; forming an image in xerographic toner by a xerographic process on the thermoplastic coating on the carrier sheet and fixing the image thereto; placing the image-bearing carrier sheet in face to face contact with a target substrate of textile material; and applying heat and pressure whereby to separate the thermoplastic coating from the polymeric surface layer of the web and to transfer it and the toner image to the textile substrate, wetting the substrate and flowing into intimate contact with the fibres thereof.

Also in accordance with the invention, an image carrier sheet for use in an image transfer process, in which an image in xerographic toner is formed on the carrier sheet by a xerographic process and fixed thereto and thereafter the carrier sheet is placed in face to face contact with a target substrate of textile material and the toner image transferred thereto under suitable conditions of heat and pressure, comprises a flexible web base having a surface layer of polymeric material, and on the said surface layer of the base a thermoplastic coating receptive to xerographic toner, the polymeric layer on the base and the thermoplastic coating being selected so that under the said conditions of heat and pressure the thermoplastic coating is capable of separating from the polymeric layer and transferring the toner image to the textile substrate, wetting the substrate and flowing into intimate contact with the fibres thereof.

The image must be formed on the thermoplastic coating (herein also referred to as a transfer coating) by means of a toner medium that can be transferred to the substrate with the thermoplastic coating material under particular conditions of heat and pressure. The toner is normally a fusible powder, and may be black or coloured. Normally it would be desired that the image should not lose its integrity during the transfer, although no doubt interesting effects could be achieved by permitting some modification of the image at this stage.

The image carrier is used in a xerographic copier in place of the usual copy paper, so that the original image scanned by the copier is used as the basis of a copy in toner formed on the receptive surface of the carrier. The toner is fixed to the coating in the usual manner for the copier, normally by passing the carrier between the copier's fuser rollers. Clearly the conditions of heat and pressure at such fuser rollers must not be those conditions of heat and pressure that will cause the thermoplastic coating to separate from the carrier web.

If the copier is provided with optical or electronic image processing facilities, it may be possible to adapt or manipulate the image before forming it on the carrier. In particular, text can be reversed in the copier, so that a second reversal of the text in subsequent face to face printing on to the target substrate will restore its normal readable form.

An image carrier intended for receiving the image by xerographic methods will desirably be flat and curl free, of a weight not more than about 110 g.s.m., and able to withstand the temperature and pressure of the fuser rollers. The overall thickness and construction of the sheet should meet the norms and standards of the copier industry.

The thermoplastic transfer coating on the carrier web must separate from the polymeric surface of the web under acceptable conditions of temperature and pressure; these conditions should not be so extreme as to damage the image or the target substrate. Suitable temperatures for printing textile materials are generally not more than 195°C, and more usually in the range from 165°C to 190°C. The temperature and pressure are typically applied for between 10 and 15 seconds, but this will vary according to the actual temperature and pressure employed, the nature of the transfer coating, and the nature of the substrate. The carrier web itself will be discarded after the coating has been transferred to the substrate and its condition at that time will not be material.

The transfer coating should be compatible with the target substrate, to the extent that under the conditions

of transfer it will wet the substrate and desirably flow into intimate contact with the fibres of the substrate in the case of textiles (woven or non-woven). It may be entirely or partially absorbed by the target substrate.

The principal functions of the thermoplastic transfer coating include carrying the image-forming medium across to the substrate, and bonding the medium to the substrate to fix the image thereon. Desirable properties include a high melt index, implying good flow properties and low viscosity.

A preferred thermoplastic coating comprises an ionomer, which although cross-linked at normal ambient temperatures becomes plastic at elevated temperatures. Typical ionomers are polymers of ethylene with small quantities of co-monomers containing carboxyl groups; since the cross-linking is ionic in character, it is temperature dependent and reversible. Preferred ionomer resins include those sold under the trade mark Surllyn.

Another preferred thermoplastic coating comprises an ethylene-lower alkyl carboxylate copolymer. Particularly preferred lower alkyl (up to 5 carbon atoms) carboxylate components are esters of acrylic and methacrylic acids; and especially preferred is ethylene-butyl acrylate copolymer (EBA). The lower alkyl carboxylate proportion may be up to 30%, preferably about 15% to 20% in EBA.

Other thermoplastic polymers of this general type that are suitable for coating the carrier web and receiving the image-forming medium include ethylene-vinyl acetate copolymers (EVA). In these, the proportion of vinyl acetate is desirably below 22%, and more preferably about 9%.

Although different coating techniques may be employed, such as melt, solution or emulsion coating, the thermoplastic coating is preferably applied to the carrier web by an extrusion process. The coating material is rapidly heated, extruded through a die and then immediately laminated to the carrier web. Excessive heating and air contact when hot are desirably kept to a minimum. Typical extrusion temperatures are in the range from 260°C to 300°C.

It may well be necessary or desirable to surface treat the thermoplastic coating in order to render it receptive to image-forming media. Treatment by a cold plasma or glow discharge, or by a hybrid plasma such as a corona discharge, or exposure to energetic radiation from an arc or the like, may be used to promote the wettability of, and adhesive strength to, the thermoplastic surface. Corona arc treatment is preferred.

The carrier web has a polymeric surface to which the thermoplastic transfer coating is applied. The carrier could be a flexible, uniform, polymeric sheet material. However, it may with advantage be a composite material, comprising a surface layer of polymer on a different base material. The base material can be selected to give particular major physical properties such as weight, dimensional stability and flexibility (or stiffness). The polymeric surface layer can be selected for its contribution to these qualities, and in addition for its qualities as a release agent under the image transfer conditions, having regard to its compatibility with, and the nature of, the thermoplastic transfer coating that it carries.

The carrier web preferably comprises a flexible woven or non-woven fibrous material, especially paper, and particularly paper impregnated with latex. Paper with latex saturation can be made extremely limp so that it will lie flat against the target substrate.

In the case of the composite carrier web, typically of a paper base coated with a polymeric surface layer, the polymeric layer can be applied by the same techniques as described above for the thermoplastic transfer coating, and especially by extrusion coating, and within the same temperature range. When coating by extrusion, it is preferred that the polymer layer and the thermoplastic transfer coating be applied in succession, with just sufficient delay to ensure that the thermoplastic transfer coating can later be separated from the underlying polymer layer during the image transfer process.

In order to ensure the later separability of the thermoplastic transfer coating from the composite carrier web it may be necessary to select appropriately different materials and/or different application conditions for the polymer layer and the thermoplastic transfer coating. Preferably, the polymer layer is of a different material to the thermoplastic transfer coating, and they are applied to the web base at different temperatures; in particular, the thermoplastic transfer coating may be applied to the polymer layer at a higher temperature than the polymer layer was applied to the web base.

An alternative method of coating a polymeric layer on to a carrier web is by roller coating. This is particularly useful where the polymer can be applied in solution or dispersion. The coated carrier may then be left to dry, or oven dried, before the thermoplastic transfer coating is applied to it.

The polymeric surface may be of the same materials (including ionomers and polyethylene-lower alkyl carboxylic esters such as EBA and EVA) as were identified above as suitable for the thermoplastic transfer coating, although preferably not the same material for each in one and the same composite web carrier material. One suitable alternative polymeric surface material is low density polyethylene (LDPE). Another is an acrylic lacquer applied by roller coating the web.

Table 1 shows suitable combinations of materials in image carrier materials according to the invention.

Table 1

Web Base	Polymeric Surface	Transfer Coating
Paper or paper impregnated with latex	Surlyn ionomer	EBA
	Surlyn ionomer	EVA
	EBA	Surlyn ionomer
	EVA	Surlyn ionomer
	LDPE	Surlyn ionomer
	LDPE	EBA
	LDPE	EVA
	Acrylic lacquer	EVA

Whether the carrier web is a simple flexible polymer web carrying the thermoplastic transfer coating directly, or a composite of a base material and a polymeric surface layer on which the transfer coating is carried, first the image-forming xerographic toner is applied to the transfer coating, and secondly the thermoplastic transfer coating together with the image formed by the toner is transferred from the web to the target substrate, with separation of the thermoplastic transfer coating under heat and pressure from polymeric surface of the carrier web.

The invention is illustrated in the following examples.

#### Example 1

A paper web is fed past two laminating extrusion dies spaced a short distance apart on the same side of the web. From the first die a melt of Surlyn ionomer resin is extruded at 280°C or preferably 290°C and laminated to the paper at a coating weight between about 7 and 12 g.s.m. to form the carrier web. From the second die a melt of ethylene-vinyl acetate copolymer is extruded at the slightly higher temperature of 300°C or preferably 310°C to form a thermoplastic coating of about 20 to 30 g.s.m. weight over the ionomer polymer layer on the paper web base. The carrier web so formed has a weight of 105 g.s.m.

The surface of the thermoplastic coating is exposed to a corona arc at an intensity of at least 45 dynes, preferably 50 dynes or more, to render it receptive to photocopier toner powder, and the image carrier material so formed is then cut into sheets.

A single sheet of this carrier material is fed into a Canon colour laser copier (eg model CLC 1, CLC 200 or CLC 500) where it receives a full colour image in fused toner powder. The image-bearing sheet is then placed in face to face contact with a white cotton tee-shirt as the target substrate, against which it is pressed for about 12 seconds at between 165°C and 190°C.

On peeling off the carrier web it is found that the EVA thermoplastic layer has separated cleanly from the ionomer resin layer on the paper base of the composite carrier, and has been absorbed by the cotton, transferring the colour toner image and fixing it to the cotton. The image is substantially unaffected by subsequent laundering.

#### Example 2

The procedures of Example 1 are repeated in coating a 70 g.s.m. paper base with 10 g.s.m. of Surlyn ionomer resin followed by 20 g.s.m. of ethylene-butyl acrylate copolymer (EBA) containing 17% butyl acrylate to give an image carrier of 100 g.s.m. weight,  $\pm 3$  g.s.m.

A full colour image is transferred to a white cotton tee-shirt in the same manner as in Example 1. It is noted that while the same actual transfer temperature of 187°C, within the given range of 165-190°C, is preferred for reasons of consistency, image-bearing EBA coatings can readily be transferred at temperatures around 20°C lower than those used for EVA based image transfer.

It is further observed that in the photocopier, the image carrier with an EBA transfer coating shows enhanced friction properties, particularly with regard to improved registration with the photocopier transfer drum. The acetate-free thermoplastic transfer coating is less corrosive to coating machinery and in the photocopier, where elevated temperatures are met. In terms of durability after repeated laundering, the image transferred in EBA shows superior life and resistance to cracking.

By using a paper base with a polymeric surface as the web, to which a thermoplastic coating acting as the transfer coating is applied, as described, much improved separation of the image-bearing layer is achieved, in comparison with a transfer coating carried directly by paper. Furthermore, the image carrier as a whole can be made of a weight, such as 100 g.s.m., and with other properties, which directly match the specifications of the xerographic copier industry, with corresponding advantages in terms of versatility and compatibility with existing photocopier equipment.

### Example 3

A 70 g.s.m. paper base is coated on one side with an acrylic lacquer by using a web offset printing method, ie using a roller to transfer the lacquer to the paper carrier web.

The web is allowed to dry and is set aside for 1 - 2 hours. The lacquer coating weight, after drying, is 5 - 6 g.s.m.

The polymer coated web is then given a 20 - 30 g.s.m. coating of EVA, containing 9 - 18% vinyl acetate, by extrusion.

The resultant image carrier gave clean and substantially permanent image transfer to cotton textiles under conditions similar to those described in Example 1.

### Claims

1. An image carrier sheet for use in an image transfer process, in which an image in xerographic toner is formed on the carrier sheet by a xerographic process and fixed thereto, and thereafter the carrier sheet is placed in face to face contact with a target substrate of textile material and the toner image transferred thereto under suitable conditions of heat and pressure, characterised in that the said carrier sheet comprises a flexible web base having a surface layer of polymeric material, and on the said surface layer of the base a thermoplastic coating receptive to xerographic toner, the polymeric layer on the base and the thermoplastic coating being selected so that under the said conditions of heat and pressure the thermoplastic coating is capable of separating from the polymeric layer and transferring the toner image to the textile substrate, wetting the substrate and flowing into intimate contact with the fibres thereof.
2. An image carrier as claimed in claim 1 wherein the thermoplastic coating has been surface treated whereby to render it receptive to xerographic toner.
3. An image carrier as claimed in claim 1 or claim 2 wherein the flexible web is a composite comprising a surface layer of polymer on a base material which comprises paper.
4. An image carrier as claimed in claim 3 wherein the paper is impregnated with latex.
5. An image carrier as claimed in claim 3 or claim 4 wherein the polymeric surface layer of the web has been applied to the base by extrusion coating, and the thermoplastic coating has been applied to the polymeric surface layer by extrusion coating, in succession, at different temperatures, and with just sufficient delay to ensure that the thermoplastic coating is capable of separating from the surface layer of the web as aforesaid.
6. An image carrier as claimed in any one of the preceding claims wherein at least one of the thermoplastic coating and the polymeric surface layer of the web comprises an ionomer or an ethylene-lower alkyl carboxylate copolymer.
7. An image carrier as claimed in claim 6 wherein the ethylene-lower alkyl carboxylate copolymer is an ethylene-butyl acrylate copolymer or an ethylene-vinyl acetate copolymer.
8. An image carrier as claimed in any one of the preceding claims wherein the polymeric surface layer of the

web comprises low density polyethylene or an acrylic lacquer.

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9. An image transfer process which comprises providing an image carrier sheet; forming an image in xerographic toner by a xerographic process on the carrier sheet and fixing the image thereto; placing the image-bearing carrier sheet in face to face contact with a target substrate of textile material; and applying heat and pressure whereby to transfer the toner image to the textile substrate; characterised in that the image carrier sheet comprises a flexible web base having a surface layer of polymeric material, and on the said surface layer of the base a thermoplastic coating; the image in xerographic toner is formed on the thermoplastic coating on the carrier sheet; and the thermoplastic coating is separated from the polymeric surface layer of the web under the applied heat and pressure whereby to transfer it and the toner image to the textile substrate, wetting the substrate and flowing into intimate contact with the fibres thereof.
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10. An image transfer process as claimed in claim 9 wherein the flexible carrier web having a thermoplastic coating on a polymeric surface layer thereof comprises an image carrier as claimed in any one of claims 1 to 8.
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EP 0 466 503 A1

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## EUROPEAN SEARCH REPORT

Application Number

EP 91 30 6342

## DOCUMENTS CONSIDERED TO BE RELEVANT

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	DE-A-2 727 223 (REFEKA WERBEMITTEL GMBH) * claims 1-19 * ---	1-3, 8-10	G03G7/00 B41M3/12
X	DE-A-2 653 645 (XEROX CORPORATION) * page 18, line 13 - line 15 * * page 21, line 5 - line 29; claims 1-24 * ---	1-4, 8-10	
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The present search report has been drawn up for all claims			
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X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

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